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DIOPHANTINE ANALYSIS.

126. Proposed by R. A. THOMPSON, M. A., C. E., Engineer Railroad Commission of Texas.

Eight persons wish to play a series of games of progressive duplicate whist. In one evening, 12 boards are played, 4 boards (and return) by one couple against each of the other three couples, the same partners being retained throughout one evening. How many evenings will be required to complete the series, and what is the order of play, it being required that each player shall play with every other player as partner, and that each couple shall play once and but once against every other couple.

Solution by A. H. HOLMES, Brunswick, Maine.

The order of play would be as follows, the first eight letters representing the players:

$$\left.\begin{array}{l} A-B \text{ vs. } C-D \text{ and } E-F \text{ vs. } G-H \\ A-B \text{ vs. } E-F \text{ and } C-D \text{ vs. } G-H \\ A-B \text{ vs. } G-H \text{ and } C-D \text{ vs. } E-F \end{array}\right\} \text{first evening.}$$

The arrangement of couples for the second evening would be: A–C vs. B–D and E–G vs. F–H, alternating as first evening.

Third evening: A–D vs. F–G and B–C vs. E–H.

Fourth evening: A–E vs. B–F and C–G vs. D–H.

Fifth evening: A–F vs. B–G and C–H vs. D–E.

Sixth evening: A–G vs. B–H and C–E vs. D–F.

Seventh evening: A–H vs. C–F and B–E vs. D–G.

It would therefore take seven evenings to *make* the series, or six evenings to *complete* the series.

AVERAGE AND PROBABILITY.

159. Proposed by J. E. SANDERS, Hackney, Ohio.

A box contains n tickets numbered from 1 to n. How many draws, on the average, will it take to draw all the numbers, each ticket being replaced before drawing again? What is the numerical result for $n=2$ and $n=6$?

REMARKS. Mr. Corey and the Proposer insist that the published solution of this problem in the May Number is incorrect. Mr. Sanders gets for $n=2$, $p=\frac{1.2}{2}+\frac{1.3}{2^2}+\frac{1.4}{2^3}+\frac{1.5}{2^4}+\ldots\ldots=3+$; and for $n=3$, $p=\frac{2.3}{3^2}+\frac{2.4}{3^2}+\frac{14.5}{3^4}+\frac{10.6}{3^4}+\frac{62.7}{3^8}+\ldots\ldots$, the sum of the first ten terms of which is 5.1. From a large number of actual trials, he obtained the following results: $n=2$, $p=2.9$; $n=3$, $p=5.5$; $n=4$, $p=8.5$; $n=5$, $p=12.31$; $n=6$, $p=15.67$; $n=8$, $p=22.66$; $n=12$, $p=41$,—values which are (he observes) approximately equal to $\sqrt{n^3}$.

As stated in the May Number, the published solution conforms to the solution of Problem IX, page 52, of Meyer's *Wahrscheinlichkeitsrechnung*, which problem I take to be similar to the one under consideration. The formula used by Professor Landis in his solution is the same as that obtained by Meyer, a formula which is only approximate, but holds with great exactness if n is large. The correct result is to be obtained from the equation

$$\tfrac{1}{2}=1-n\left(\frac{n-1}{n}\right)^i+\frac{n(n-1)}{2!}\left(\frac{n-2}{n}\right)^i-\frac{n(n-1)(n-2)}{3!}\left(\frac{n-3}{n}\right)^i$$

$$+\frac{n(n-1)(n-2)(n-3)}{4!}\left(\frac{n-4}{4}\right)^i+,\text{ etc.},$$

where n is the number of numbers and i the number of drawings. This is Meyer's answer to his Problem VIII, which reads: Eine Lotterie besteht aus n Nummern, in jeder Ziehung wird eine davon gezogen. Es soll die Wahrscheinlichkeit π gefunden werden, dass in i Ziehungen alle nummern erschienen sind.

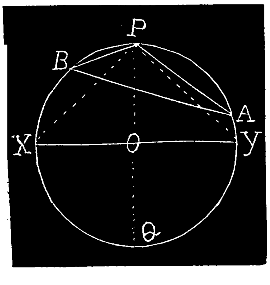
Professor Matz insists that the solution of Problem 158 in the May Number of the MONTHLY is also incorrect, his contention being that to take an arc for every point on AC and BD would not be taking them uniformly on AB. In reference to this contention, we must again call attention to Dr. Moore's *Note on Mean Value*, page 303, Vol. II of MONTHLY. The problem as stated is indefinite, and thus one may choose any law of distribution he wishes. Accordingly, the published solution is correct according to the law of distribution chosen. Other laws of distribution may be chosen, giving other results. ED. F.

161. Proposed by F. P. MATZ. Sc. D., Ph. D., Reading, Pa.

A triangle is inscribed at random in a circle; (a) what is the chance the triangle is *oblique;* and (b) what is the chance the triangle is *less in area* than $\frac{1}{4}\pi r^2$?

Solution by the PROPOSER.

(I) Put $OP=r$, $\angle APO=\theta$, $\angle BPO=\phi$; then $\triangle APB=2r^2\cos\theta\cos\phi\times\sin(\theta+\phi)$. In order that $\triangle APB$ may be *obtuse*-angled at P, the point A is restricted to the arc PAX, and the point B to the arc PBY. The required chance, therefore, becomes



$$C_1=\frac{2r^2\int_{\frac{1}{4}\pi}^{\frac{1}{2}\pi}\int_{\frac{1}{4}\pi}^{\phi}\cos\theta\cos\phi\sin(\theta+\phi)d\phi d\theta}{2r^2\int_0^{\frac{1}{2}\pi}\int_0^{\phi}\cos\theta\cos\phi\sin(\theta+\phi)d\phi d\theta}$$

$$=\frac{\int_{\frac{1}{4}\pi}^{\frac{1}{2}\pi}[2\sin^2\phi\cos^2\phi-\frac{1}{2}\cos^2\phi+(\phi-\frac{1}{4}\pi-\frac{1}{2})\sin\phi\cos\phi]d\phi}{\int_0^{\frac{1}{2}\pi}[2\sin^2\phi\cos^2\phi+\phi\sin\phi\cos\phi]d\phi}$$